Computer-Aided Design (CAD) Tools to Support Human Task Worksite Design

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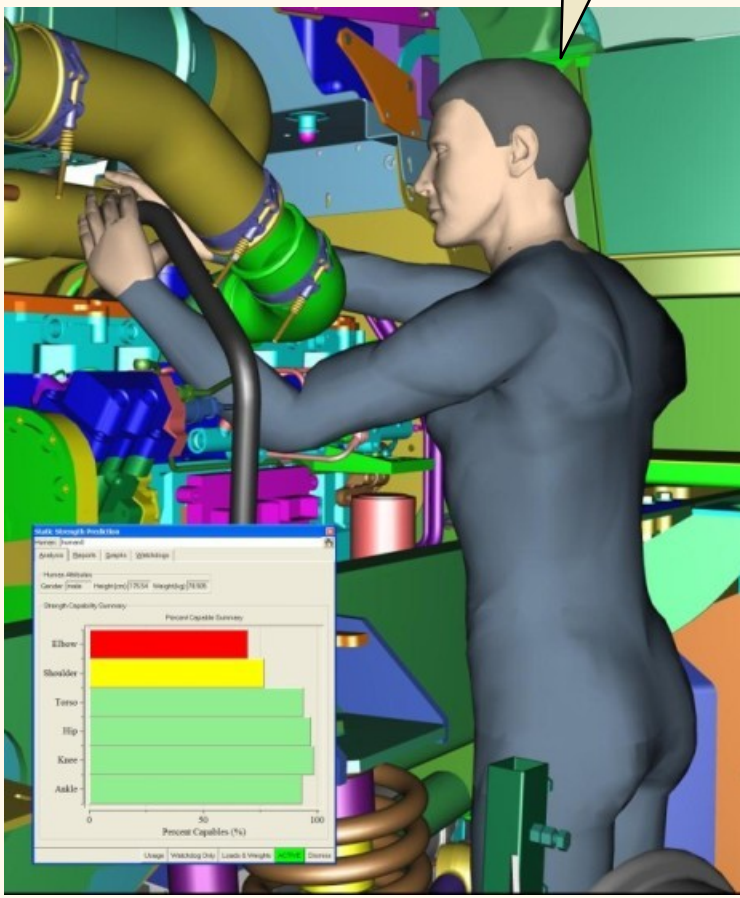
Human Modeling Postures and Motions Library

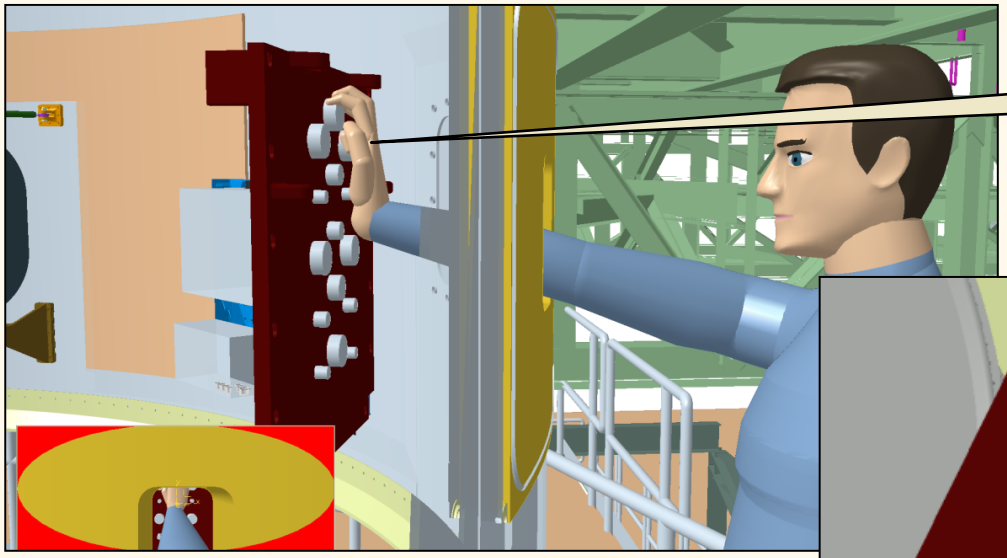
The issue; why we pursued this

- **MSFC is responsible for worksite design for ground processing of NASA launch vehicles**
- **Digital human models for analysis lack behaviors**
- **They are unaware of gravity, so:**
  - **Have no Cg**
  - **Do not understand how humans (all land animals) solve simple physics problems**
    - ***e.g.*, step through hatch**
- **Posing the mannequins is time-consuming**

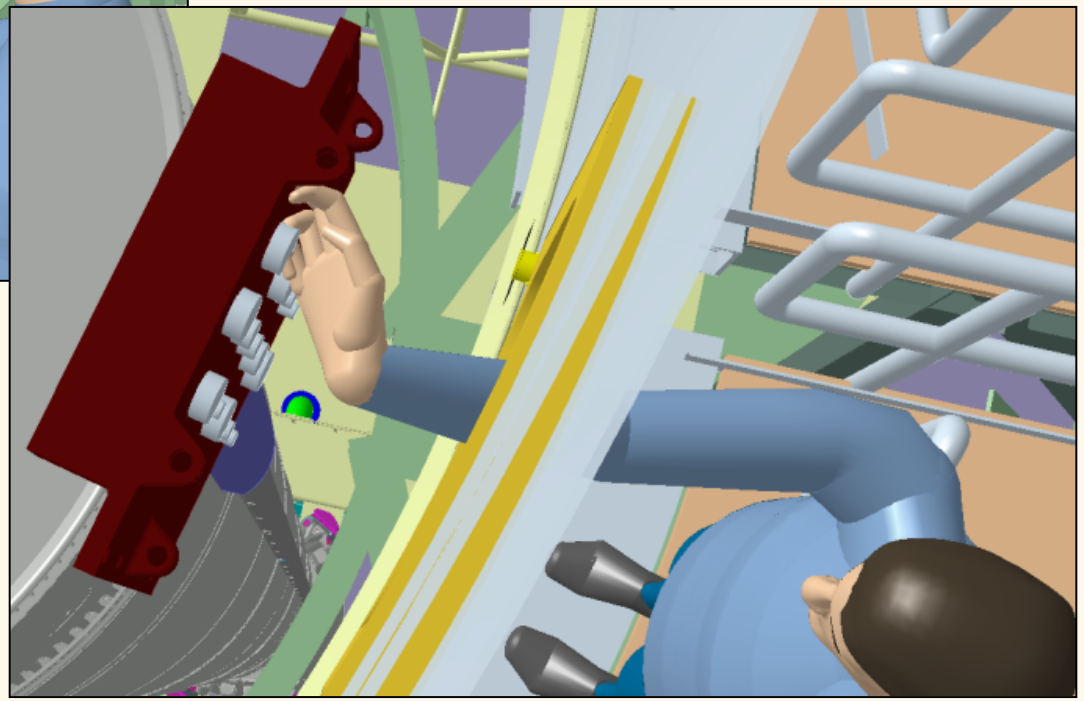


Human Modeling Postures and Motions Library

Electrical connector mate



Unnatural body positions



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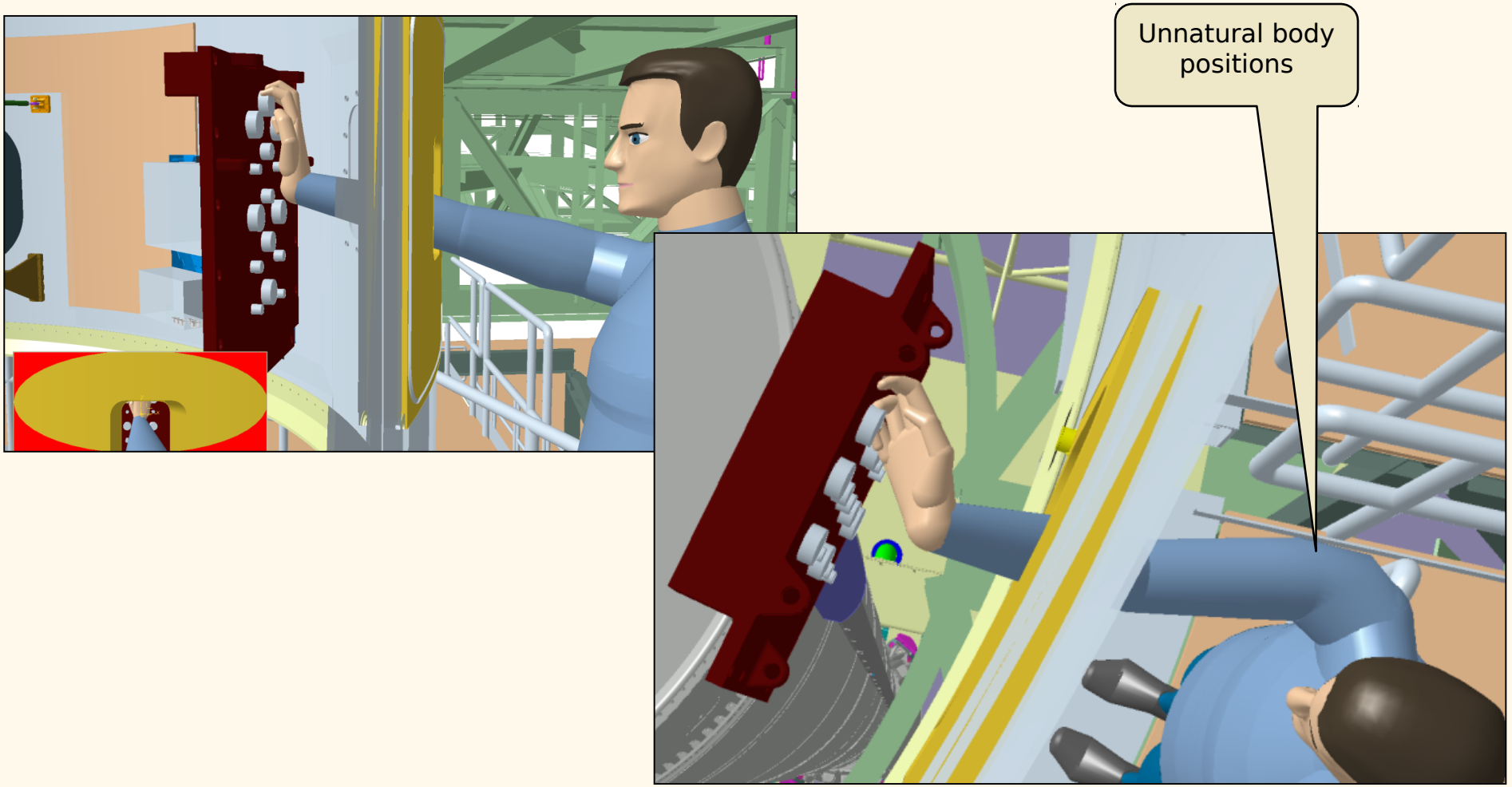


Human Modeling Postures and Motions Library

Another complication from virtual simulation as an analysis tool: discovered that analysts don't think of everything

Human Modeling Postures and Motions Library

Goal

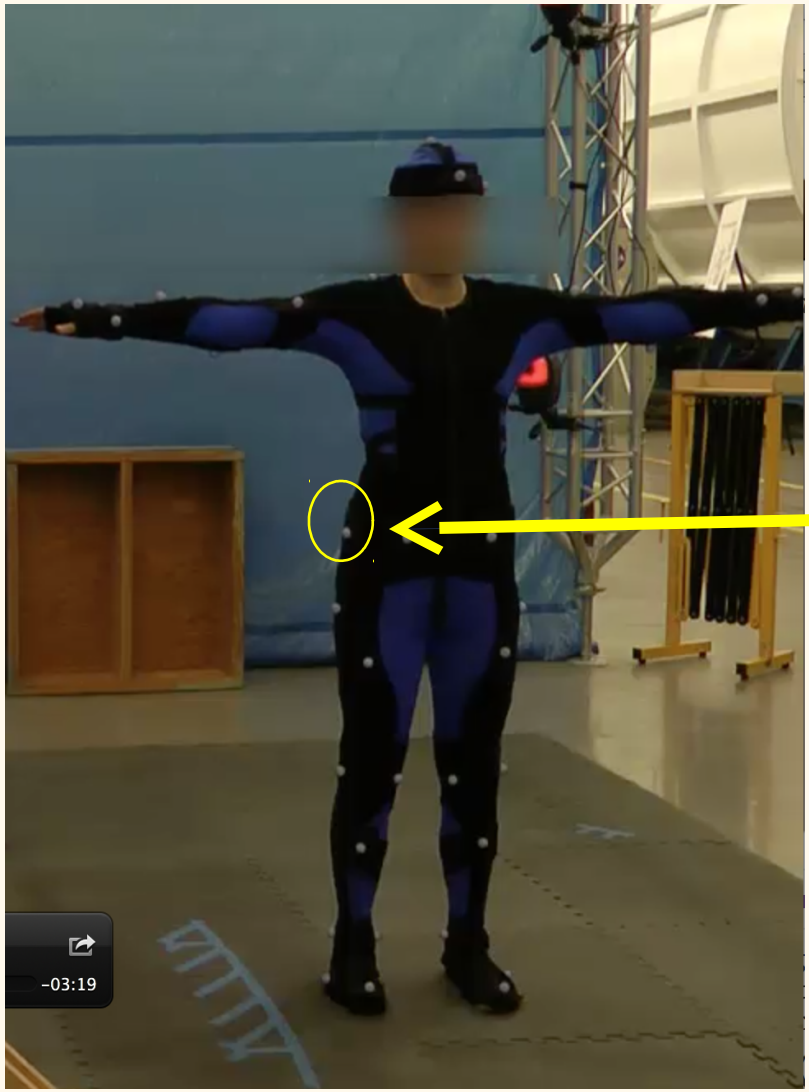
- **Develop a library of postures & motions for use by analysts in worksite design**
- **Base the library on data collected on real humans performing generic functions similar to those performed by ground crews at the NASA launch site, Kennedy Space Center**
- **Analysts could then use complete or partial motions and postures to incorporate into analysis**
  - **Speed the analysis**
  - **Have it be more realistic**
  - **Identify requirements that might not be considered by an analyst in virtual simulation**
    - **Handles on hatch frames**

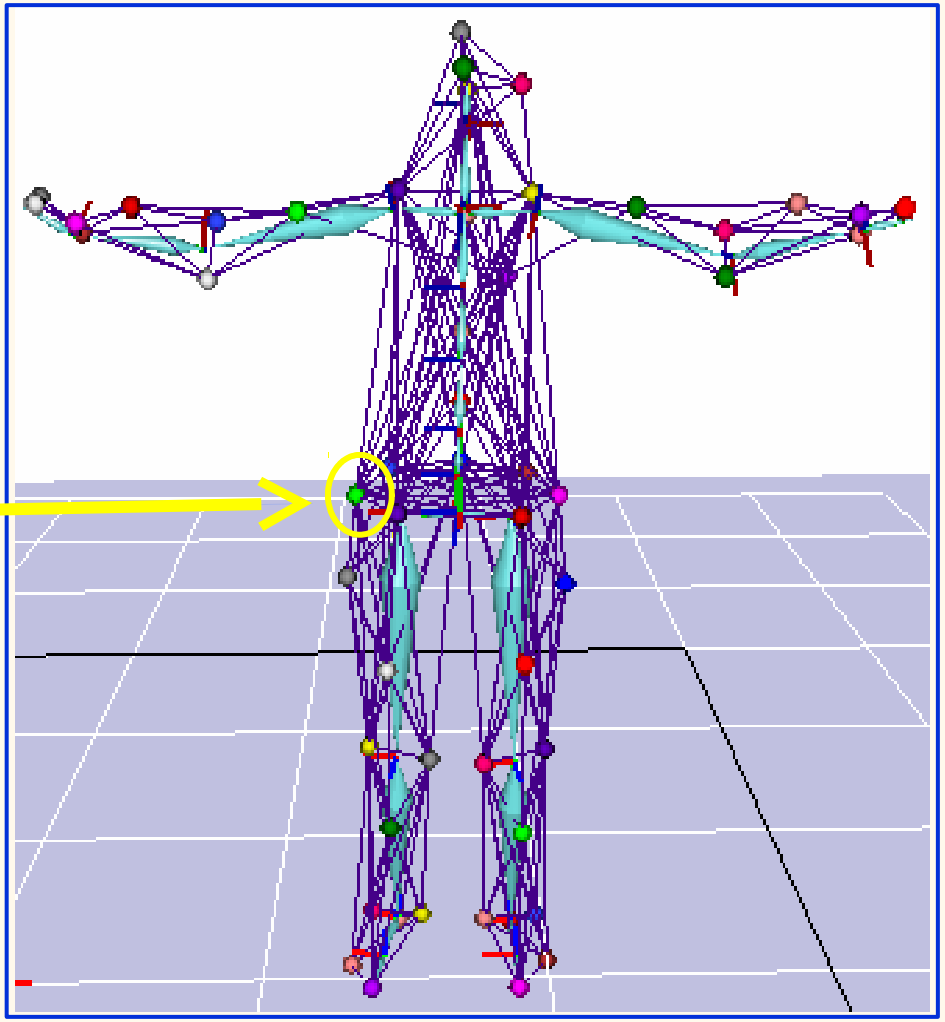
Human Modeling Postures and Motions Library

Method

- **Motion capture system:**
  - **Motion Analysis Corp.**
  - **12 capture cameras (mixture of Hawk & Owl)**
  - **Cortex software**
- **Capture data on human participants**
  - **Minimum: one each, 5th – 95th %ile**
  - **53 markers captured on each**
- **Capture data was post-processed to remove extraneous data**
  - **Markers subject to occlusion, inclusion, and becoming "unnamed"**
    - **Occlusion is a physical limitation; data loss**
    - **Inclusion is a software phenomenon that requires "untangling" by hand**
    - **If marker becomes "unnamed," the software has moved it to a location in the virtual space that does not correspond to its physical location**
      - **Again, the fix is by hand**
      - ***A*nalyst "renames" a misplaced point as, *e.g.*, the elbow marker**
- **Once cleaned, a capture could be used to create a Jack "Channelset"**
  - **This is, essentially a script that moves the DHM**
  - **The imported Cortex script feeds the Channelset**

Human Modeling Postures and Motions Library





Human Modeling Postures and Motions Library

Product: library for use in analysis

- Database is accessible through a browser interface
- User's Guide is available
- Scripts decomposed into:
  - Functions ("Hatch operations")
  - Tasks ("open & ingress hatch")
  - Subtasks ("open hatch")
  - Elements ("remove hatch fastener")
- An analyst selects the size of script needed for the analysis
- Analyst has flexibility to use a particular participant's data
  - Anthro data for each is given
- Current drawbacks:
  - Not accessible from outside Marshall
    - This is a funding issue
  - The browser interface accesses (Jack) Channelsets
    - Cortex data are available for others to import into their DHM

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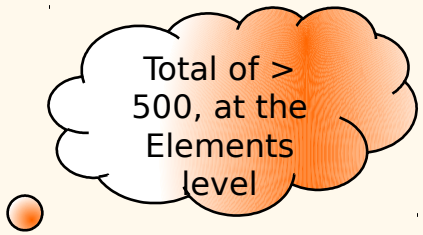

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  - Universality (who would use?): ??

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